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Local Structure Study on Tantalum Oxide as a Passive Film Formed on Alpha- and Beta Tantalum

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Beamline(s): X11A

Introduction: Passivity is generally ascribed to the presence of a thin oxide film 1-4 nm thickness, which isolates the metal surface from the corrosive aqueous environment. The resistance of this anodic oxide film to dissolution is related to its physical and chemical properties, which determines the corrosion resistance of the metal (1).

Extended x-ray absorption fine structure (EXAFS) has been used as one of methods to investigate the properties and role of passive film formation on tantalum to support the understanding of corrosion mechanisms of tantalum with different phases such as alpha and beta.

Methods and Materials: A fine-polished alpha tantalum foil and a beta tantalum coating on steel substrate were anodically oxidized in 0.5 M H_2SO_4 solution with a constant current density of 0.7 mA/cm^2 under room temperature (2). Tantalum pentoxide (Ta_2O_5) powder was used as a reference. EXAFS data have been collected in total electron yield mode.

Results: Figure 1 shows the anodic oxide (blue color) formed on alpha phase tantalum foil (A) and beta tantalum coating (B) under the identical experimental condition. During oxide formation at a constant current, the alpha tantalum foil showed steady state potential, while a transient fluctuating potential was observed for the beta tantalum coating. The unsteady state potential measured for beta Ta coating appears to be due to the dissolution of substrate through defects on the coating surface. EXAFS data in TEY mode collected from the anodic oxide are under analysis.

References: [1] B. MacDougall and M. J. Graham, "Growth and Stability of Passive Films" in *Corrosion Mechanisms in Theory and Practice*, P. Marcus and J. Oudar (Marcel Dekker, Inc., New York, NY, 1995): p. 143-173

[2] O. Kerrec, D. Devilliers, H. Groult, P. Marcus, "Study of dry and electrogenerated Ta_2O_5 and Ta/ Ta_2O_5 /Pt structures by XPS," *Material Science and Engineering B55* (1998), p. 134-142

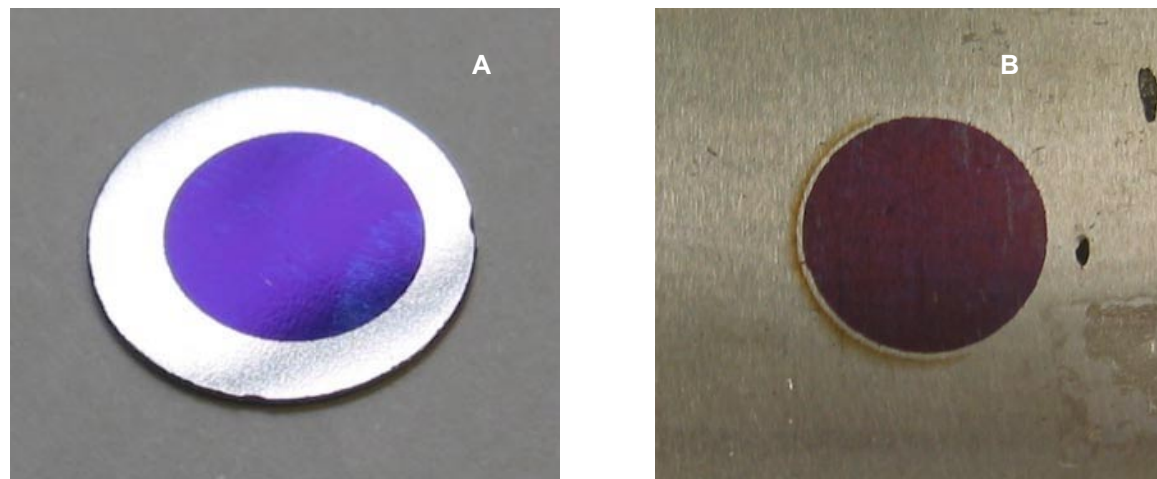


Figure 1. Photograph of anodic oxide formed on alpha tantalum foil (A) and beta tantalum coating.